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Concentration Agreements

At the present time foundry owners in one district are exercising their minds with the object of making an agreement of an equitable character for the temporary handing over on the one side, and receiving on the other, of going concerns. This is not easy, and but few lawyers can have had experience of such deals. So far as we can see, the agreement has to envisage two distinct phases. The first is the establishment of the principle for a basis of financial compensation and the second to cover the technical side. In the latter case there may be involved the loaning of personnel, their payment and the ensuring of their ultimate return to their original employment. Again, for certain jobs, special mixtures are used and their disclosure presents difficulties. Thus the question arises, should an attempt be made by either side to keep them secret or is full disclosure called for? Furthermore, two amalgamated foundries having been supplying lines of castings to the same customer, at what price should they now be invoiced? There should be an initial recognition that none of the questions has any direct relation to the war effort, but appertain to the post-war period and must therefore be considered as secondary. Now, being secondary, they should be capable of adjustment by the exercise of a genuine desire to co-operate. In considering the case of loaned personnel, it is useless binding a man to return if he is more comfortable in his new environment, and the inclusion of third-party clauses will in the end only enrich the legal profession. A sporting attitude to this question is better than half a page of legal jargon. Next, there is this question of mixtures for various jobs. Here we suggest that if at all possible there should be the fullest exchange of technical information, for neither party has a monopoly in excellence of technique. Moreover, an agreement saying that this co-operation should be continued for the post-war period would ultimately benefit all parties. A difficulty naturally arises where a foundry is operating under a process licence, for in this case the foundry owner is not his own master, and this should be recognised. Price difficulties can best be arranged by according to the customer an intermediate figure, the proceeds of the sales being distributed on an arithmetical ratio. Where either party has been supplying the complete requirements of a firm for a substantial period, then "reserved" lists should be prepared. The above applies more especially to the amalgamation of firms of competing interests. In some cases, the grouped foundries cater for entirely different industries. In others the closed foundry is only a department of a large works. However, no matter what the nature of the grouping there is certain common ground and a memorandum prepared after the experience of the first district to be concentrated would be of extreme value, when the order is extended to others. The main object of such a memorandum would be to outline in the simplest possible terms the essential clauses for working of the grouped interests, bearing in mind the objects which have actuated the Government in their decisions: economy of fuel, of transport and of man-power, and therefore increased output. Then it does seem advisable that a list of pointers should be given as factors which may be worth while incorporating in an agreement in some cases and ignoring in others.

For the real issue there is but one thing, and that is for the foundry owners to get together and discuss the whole problem from all angles and arrive at the fullest measure of technical co-operation to protect their own interests and frame a co-ordinated policy for the future.

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OLD CASTINGS FOR PATTERNS

BY "CHECKER"

On a breakdown job a casting may be urgently required to replace one that is cracked or broken, and by utilising the old casting for a pattern, the new part can in many cases be produced much quicker, for although the moulder will take longer on his mould, the patternmaker's time will be cut to such an extent that the net gain will be considerable. A pulley wheel shown in Fig. 1 is a case in point where it was decided to clean the casting and use it for a pattern, machining allowance being required where marked *f*. The bore was first filled in by driving in a piece of wood at each end; this makes a solid foundation to fasten the machining allowance and prints on the centre boss, Fig. 2.

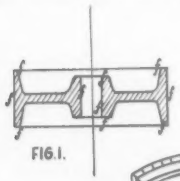

FIG.1.

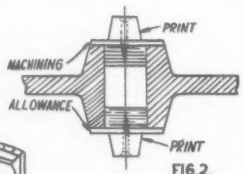

FIG.2.

FIG.3.

Segments were stuck on the top and bottom of the rim with thick shellac for machining allowance, and the machining on the outside diameter of the pulley was obtained by placing pieces of wood the depth of the rim by half an inch wide (Fig. 3); these were held in position by string tied round the diameter, which was taken away after the pieces had been bedded round with sand in the mould. Contraction allowance was allowed where machining was added, and a standard core used for the bore. The rim of the new casting was thicker and the diameter of the centre boss slightly less than the original, due to the contraction.

WHY WE ARE SMALL

Our pre-war paper consumption was x. The Paper Controller now insists that it must be reduced to $x/5$.

x is usually made up of two components, $a + b$, where a is paid circulation and b is the number of free copies.

Where b is 80 per cent., no change other than suspending the free list is necessary to reduce paper consumption to $x/5$.

But where a is 100 per cent., then to maintain pre-war circulation, the cut to $x/5$ must be enforced.

Hence our small size.—Q. E. D.

CORRESPONDENCE

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Jobbing Foundry Organisation

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Your leading article of March 26, 1942, was referred to at a recent meeting of the Executive Committee of this Association. The members (being almost entirely jobbing founders) are appreciative of the trend of your comments in this article, and they sincerely trust that your effort will reach "home" to all those independent jobbing founders who have not yet seen fit to link up with any association for the improvement of the industry as a whole.

Our members, however, were very strongly of the opinion that your unfortunate wording, linking jobbing founders with the I.N.C., may have created a certain amount of misapprehension in the minds of the small jobbing founders. I was therefore asked by the members of the Association to call your attention to the fact that the proper associations best able to deal with the problems of the jobbing foundry are the local associations, which together form the National Ironfounding Employers' Federation, which, in its turn, is the largest constituent in the Council of Ironfoundry Associations. These local associations have, for the most part, been in existence for a great number of years, are well established, and have had much experience in the needs of the jobbing ironfounder. Their activities are mainly confined to their respective areas, and they have national contact through the N.I.E.F. Moreover, through the efforts of these local associations, the standard of the jobbing foundry trade has been raised to a much higher level than formerly existed. These local associations are by no means satisfied with the amount of progress that has been made, and this is largely due to the unwillingness of so many jobbing ironfounders to associate themselves with their competitors. They seem to find it difficult to realise that competitors are not people to be avoided, and that co-operation for all concerned can achieve good results. At the present time these local associations are doing much to alleviate the difficulties brought about by war conditions, and, through the National Ironfounding Employers' Federation, they represent a very formidable and useful organisation, capable of helping both their members and the Government in the day-to-day problems which arise in wartime.

We therefore respectfully suggest to your readers that the best interests of all would be served by those jobbing ironfounders with a business restricted to a local area, joining their local association, whilst those foundries whose products have a national, rather than a local, appeal, or who, for any other reason, consider the local association inadequate for their requirements, should be invited to join the Ironfounders' National Confederation.—Yours, etc.,

THOMAS LEE,
President.

Manchester and District Ironfounders' Employers' Association. April 27, 1942.

CONTROL IN THE REPETITION FOUNDRY*

AN ANALYSIS OF MODERN PRACTICE

By A. B. Bill

(*Continued from page* 29.)

Added Importance of Cores

Due, in large measure, to the intricacies of modern designs, cores play an increasingly important part in the foundry, and although it is not necessary, here, to comment on the actual art of core production, something may be said of the details, small in themselves, which do give trouble and increase rejections. Core flash (Fig. 11), particularly noticeable with blown-up cores, or from badly registering loose pieces in the corebox, is often difficult to remove, but may leave a slot in the casting necessitating welding which is more costly than a little initial care.

Core drying, thanks to the efforts of the stove

FIG. 11.—SHOWING FLASH LEFT ON CORE AND RESULTANT SLOTS IN BRAKE SHOE CASTING.

manufacturers, is something taken almost for granted, but soft undried cores do appear sometimes, or improperly dried oil-sand cores may absorb moisture from the air if left for any length of time. These if sagged should be rejected, or, if not, redried. Open vents (Fig. 12) and crushing cavities should be stopped off and a close clean skin insisted upon.

Assemblies of two or more cores, or half-cores, should be checked by a simple jig or gauge, particularly from the danger of worn strickles or strickled faces on the corebox. In some cases, particularly with fairly large half-cores, it pays to leave a small amount of excess sand on the joint face and locate the core in a rubbing jig, which is a facsimile of the mould prints, in order to ensure accuracy. This phase is shown in Figs. 13 and 14.

FIG. 12.—SHOWING EFFECTS OF OPEN VENTS IN CORE.

How much core inspection should be left to the moulder himself, and how much should be part of the coreshop inspection department will depend largely on the need for dimensional accuracy of the particular job. The piecework moulder will in his own interests see that any core he uses is visually perfect, but it will be acknowledged that his job is moulding and not inspection, and that in the main he should be freed from responsibility for cores. Dimensionally important cores should be checked by gauging where necessary, and cores

* A Paper presented to the Lancashire Branch of the Institute of British Foundrymen, Mr. W. Holland presiding.

Control in the Repetition Foundry

which do not conform to gauge rejected. It should be demanded that registers or "go by's" are clearly defined and intact.

Jig Setting of Cores

Great care should be taken in locating cores in the mould, and again a simple jig or gauge (Fig. 15) is of value, particularly with cores which have of necessity only a small print bearing, as, for example, barrel cores located vertically. Repetition machining allows for only a very limited amount of locational error, and the machine shop is chary of increasing allowances to overcome discrepancies. Surely no machine shop reject is more heart-breaking than an otherwise perfect casting, free from blow holes and porosity, which has failed to clean up during machining.

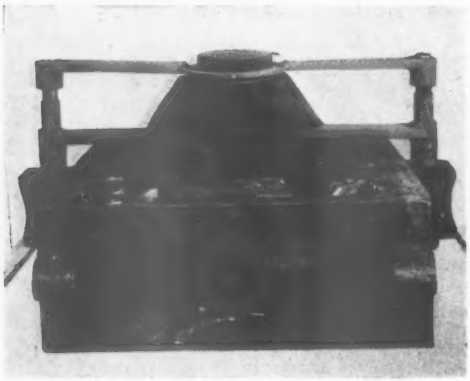

FIG. 13.—SHOWING LOCATION OF TWO HALF CORES IN PLASTER FACSIMILE OF MOULD PRINT WITH SIMPLE STRAP GAUGE LOCATING ON PIN TO ENSURE CONCENTRICITY.

Equal emphasis is placed on the necessity for correct location of snap flasks, box parts, and the registering of assembly pins, box pins and bushes in order to prevent off-set castings. Pattern equipment should be cleaned frequently, and careful inspection made for general wear and tear or loosening of dowels; particularly it should be noted that brackets and fillets, so necessary to prevent tearing or cracking, have not been broken away.

Inspection Department

Having considered various defects and their origin in the foundry, the author desires to deal fully with the actual internal castings inspection department, to discuss its routine activities, and more particularly its scope, and to point out something of its value to the foundry executives. The primary function of the inspection department, it will be agreed, is to reject those castings which would obviously be rejected by the customer or machine shop, if allowed to pass on.

This, however, is only the commencement of the duties of the internal inspection and, as was pointed out editorially in THE FOUNDRY TRADE JOURNAL of October 31, 1940, "the type of inspector whose sole object in life is to condemn as much material as possible as being defective has no place in any progressive organisation." Indeed, a departmen which held that object only in view might wel prove more of a liability than an asset. At the same time, its constant endeavour should be to ensure that each casting released to the customer is, as far as can be ascertained visually, perfect within the limits usually associated with it.

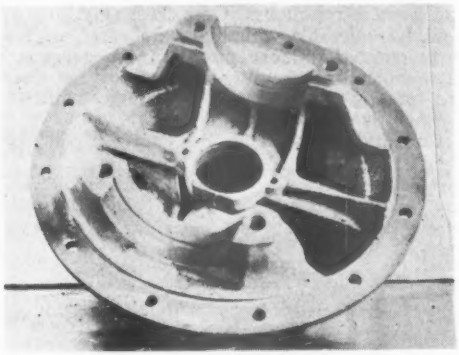

FIG. 14.—SHOWING CASTING FROM (I) MACHINED UP ILLUSTRATING NEED FOR ACCURACY.

Quality and finish should be kept as far as possible to predetermined standards, and a system of "Go" and "Not go" gauges built up to ensure dimensional accuracy. Apart from this primary job of inspection, however, there are many ways in which the department can help in the reduction of foundry scrap. A regular analysis of castings passing through the department should, if possible, be returned to the foundry, showing the number passed on, the number rejected and the reason for rejection. Whether this is done for every casting made, and whether it is a daily or weekly analysis, will depend to some extent on the scope of the

Control in the Repetition Foundry

department, the nature of the particular job, and how much scrap is habitually made. Apart from this record, however, rejects should always be on view in the department, so that they may be seen and discussed by the foundry foreman concerned. This will ensure that he agrees they should be rejected, and also that there is agreement as to the cause of rejection so that steps can be taken to minimise the possibility of a recurrence of the trouble.

Notification of Faults

Due to the inevitable time lag between moulding and inspection (which, even in highly mechanised units must amount to the time necessary to allow for cooling and cleaning), immediate notification of faults, together with a sample showing the defect must be made to the foundry foreman

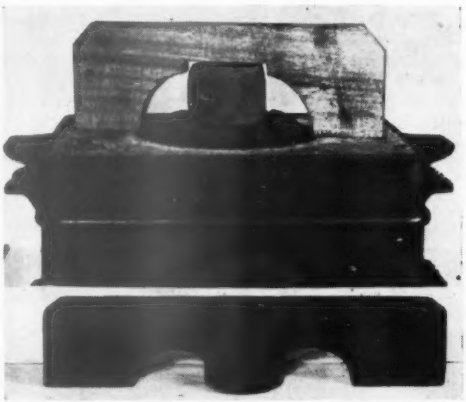

FIG. 15.—SHOWING LOCATION OF CORES IN MOULD CHECKED BY SIMPLE STRAP GAUGES. (THIS IS THE "ROSETTE" CORE REFERRED TO IN DISCUSSION.)

concerned. A delay of only a few minutes may mean another box of potential scrap put down on the floor. Obviously, in manually operated foundries, the delay will be longer and waste of time more serious, except that, with batch melting, it may be possible to prevent the casting of definite waster boxes, and so save melting costs and perhaps cores.

If a defect can be definitely attributed to the coreshop then the coreshop, too, should be notified, since production there will be ahead of moulding and waste of time and material more expensive. Daily and weekly assessments of defects are made on the forms shown on Charts I and II, the figures of which are obviously hypothetical.

Pattern Inspection

Although pattern equipment should be checked over before a pattern is put into work, after a period in the pattern stores a sample casting should be inspected and passed before the foundry proceeds with the bulk order. The sample may show up faults which will save the first day's production from rejection or perhaps the cost of subsequent rectification. Even though the pattern is not new and thousands of castings may have been successfully made before, it does not always follow, after a prolonged stay in the stores, that the new castings made from it will be of the same quality as the previous batch.

During transit from stores to foundry a thin metal flange may have been accidentally bent, a necessary fillet may have been removed during renovation; a new coat of varnish may cover an indication that a certain boss is to be chilled. Possibly a bad bruise may have escaped the attention of the foundry foreman or moulder.

Despite the efforts of the patternshop to provide adequate printing and simple location and registering, intricately cored jobs often have their own little peculiarities which only experience can illustrate. This is particularly so where it is not possible to assemble cores before coring up and where all are located separately in the mould. Where the prints are not foolproof, a certain core may need holding down in a particular way to avoid eccentricity; another may need judicious filing to prevent crushing.

Breaking up the sample will reveal inside defects, such as blowholes, deep slag inclusions or shrinkage. Steel and low-carbon irons may show contraction tears necessitating "ties" or brackets which cannot conveniently be fixed to the pattern and need to be cut by the moulder either in the mould or the core.

Defects Exaggeration by Metal Differences

Moreover, a sample may show up tendencies towards faults, which is of as much value as the showing up of actual defects. Although laboratory control of the metal is of necessity so close as to need no comment, variations can, and do, take place in melting conditions and the resultant temperature of the metal. Thus, a slight draw in a casting poured from to-day's relatively cool metal may become a wide open tear with to-morrow's hotter iron. Conversely, a slight skin blister from

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to-day's hot iron may mean a bad blowhole from to-morrow's sluggish metal. Slight core misplacement usually develops, if not checked immediately.

Typical simple weekly scrap analysis. One moulder only showing cause of rejection.

Scrap Analysis—W/E. 21/11/39.

Customer: Jones. Part No. 43267. Moulder: Smith.

Weigh.	Blown.	Mis run.	Mis-placed core.	Sand incl.	Slag incl.	Broken in.	Crack.	Swollen.	Total rejects.	Good casts.
1st	7	0	2	0	2	0	1	1	13	64
2nd	9	1	1	1	1	1	1	0	15	44
3rd	3	0	1	0	1	0	0	0	5	53
4th	8	0	1	0	7	2	0	4	22	45
5th	7	0	0	0	4	0	0	1	12	72
Total	34	1	5	1	15	3	2	6	67	278

Percentage rejected: 19·4. Remarks: Blown.

The presence of small amounts of loose sand inclusions often points to a badly registering core, which may need easing slightly in the print to prevent the possibility of a batch of oversize cores, either from a badly worked corebox or due to spreading while green, crushing the mould badly.

Fettling Considerations

Again, for the benefit of the grindery and fettling shop, attention to size and disposition of runners and feeder heads, the reduction of unnecessary "flash" due to worn coreboxes or faulty core location and the checking of slight misplacements and cross-joints can considerably reduce fettling costs. Too much enthusiasm on the moulder's part in rubbing or filing cores to prevent crushing, or the cutting of too large or unnecessary "ties," are both points well worth the attention of the inspectors. Badly placed core wires fused into the casting take time to remove, and the same applies to sprigs, used for holding down cores, which are left standing proud of the core and become fused. Care should be taken to see that these are always sleeked over.

It is perhaps a small point, but even the despatch department can benefit from a careful check on the clarity of the customer's trade mark and part number. This is especially so where there is a marked similarity between two patterns or a right- and left-hand pattern of the same job. A distinct number is a more certain check than any amount of familiarity with the particular job. Clean, distinct part numbers are of assistance to the customer, too, since many parts for replacement are ordered from them by number as well as a description of the part.

The inspection department may find it difficult to persuade the foundry to remedy small defects

Typical simple daily scrap analysis. Five moulders making the same job, showing causes of rejection.

Scrap analysis—W/E. 16/11/39.

Customer: Jones. Part No. 43267. Moulder: Smith, etc.

Man.	Blown.	Mis run.	Mis-placed core.	Sand incl.	Slag incl.	Broken in.	Crack.	Swollen.	Total rejects.	Good casts.
"X"	3	1	1	3	1	1	0	0	10	41
"S"	7	0	0	1	1	0	0	0	9	39
"N"	3	0	0	0	2	0	1	1	7	15
"Q"	6	0	6	0	2	0	0	1	15	36
"T"	4	0	5	2	5	0	0	2	18	41
Total	23	1	12	6	11	1	1	4	59	172

Percentage rejected: 25·5. Remarks: Blown.

and irregularities, for two reasons. First, because it may be considered that a job is too urgent to be held up for minor details which do not affect the utility of the product and are only a matter of finish. Secondly, because the foundry is often only too happy to get the job past the rigours of inspection without worrying any more than is necessary about processes which have to follow.

From the customers' point of view, the inspection department must help by conforming rigidly to any particular dimensions asked for, particularly where these are unavoidably determined by cores whose position can vary. Care must be taken to see that machining location points are kept clear whether they are moulded or are of necessity cored. Offset castings should be rejected unless they can be cheaply rectified or the customers consulted to ascertain whether they would be prepared to accept the faulty castings in a batch and alter their location to suit discrepancies.

Quality of material, machinability, or perhaps speedy production may be salient features in the sale of castings, but quality of finish and attention to customers' special requirements will at least improve relations, and should not be overlooked as a contributary feature.

More Co-operation

Finally, the closest liaison between the customer and the foundry should be maintained to their mutual benefit. Routine visits by a responsible executive should be maintained, during which detail changes of design which may become necessary can be discussed in relation to their effect on production. In order to rectify defects speedily, either of dimensional inaccuracies revealed during jigging and location or material defects during machining, a regular record and analysis of machine shop rejects and their causes, is essential, and will usually be found to bear close relation to the internal scrap record.

The author has endeavoured to outline some of the features necessary to ensure the regular production of a reliable product and to safeguard the possibility of releasing to the customer any defective castings, whatever the defect may be. From the initial layout of the job and sampling, through all the manufacturing processes to the final inspection of the castings, he advocates as close and rigid a control as may be deemed necessary, in order, not only to maintain the standard of work but to keep the executives of the foundry in touch, promptly and regularly, with any defects, tendencies or deviations from standard of quality. This not only maintains the reputation of the product, but assists in avoiding internal waste and inefficiency. Particularly, a thorough detailed inspection which, while it may not be a stage of production, will surely pay for its introduction.

In conclusion, the author would like to express his thanks to the directors and management of Ley's Malleable Castings Company, Limited, Derby, for permission to publish this Paper and for the loan of slides, also to Mr. J. Roxburgh, foundry manager, for his encouragement.

(To be continued.)

U.S. MANGANESE

A vast manganese production programme from low-grade domestic ores in the United States has been announced by the Director of Materials. Seven small projects and three large ones have been recommended for Federal financing. The new plants, plus those already in operation, should produce well over 600,000 tons a year in high-grade manganese concentrates, as compared with 30,000 tons domestically produced in 1939 and 40,000 tons in 1940. Investigations by the Bureau of Mines and Geological Survey have developed methods that will produce high-grade manganese concentrates from 10 to 12 per cent. ores.

These methods will be applied on the three large projects that will produce more than two-thirds of the expanded output in the Cuyuna Range of Minnesota, the Missouri River area in South Dakota and in the vicinity of the Boulder Dam in Nevada. The Cuyuna Range, largest of the three projects, has presented the most difficult extraction problem. The method finally adopted is a sulphuric and sulphurous acid leach, by which manganese sulphate is formed, then kiln-treated to produce 60 per cent. manganese oxide concentrate. More than 1,000,000 tons of ore a year will be treated in the area. Ore for the operations will be purchased from private producers.

In the South Dakota area, 16 per cent. manganese concentrate will be extracted from 1 and 2 per cent. manganiferous shales. Ore dressing followed by a blast-furnace smelting process will be used to extract the metal from some 5,000,000 tons of clay annually. At the Nevada mill, a sulphurous acid method will be used on 20 per cent. ores to produce 60 per cent. concentrates. The plant will handle 300,000 tons of ore annually. In addition to these three large projects, seven small ore dressing plants are to be built in Arkansas, Montana, Utah, Nevada, Georgia and Tennessee to treat production from small mines. These plants will treat from 150 to 500 tons per day of crude ore.

Meantime, the United States has a sizable manganese stock pile, which with domestic production and imports from Cuba, will enable steel production to go forward without interruption until the new manganese mills are completed.

INSTITUTE OF BRITISH FOUNDRYMEN

NEW ELECTIONS

At a meeting of the Council of the Institute of British Foundrymen, held at the Midland Hotel, Manchester, on April 18, the following were elected to the various grades of membership.

Subscribing Firm Members

Stevenson Bros. (representative, J. Stevenson), Industrial Sites, Benoni, South Africa, foundry merchants; Phosphor Bronze Company, Limited (representative, C. T. Hyslop, joint managing director (production), Birch Road, Witton, Birmingham, 6.

Members

J. H. Gale, foreman and designer, Magnal Products; W. C. McCormick, foreman, Magnal Products; A. Pearson, foundry manager, Clyde Alloy Foundry; H. C. T. Sims, patternmaker, Magnal Products; H. Balme, foundry foreman, Kaye & Company; R. F. Hudson, chief metallurgist, Phosphor Bronze Company; E. J. Kelly, foundry foreman, Brown Lenox; A. D. Kirby, assistant foundry manager, Coltness Iron Company; J. Roberts, metallurgist, Darlington Forge; H. Scott, foundry director, H. Edie & Company; R. Credland, general manager and director, Widnes Foundry; A. B. Lloyd, production director, F. H. Lloyd & Company; F. A. Rivett, metallurgist, Birmingham Electric Furnaces.

Associate Members

D. W. Atkinson, inspector, Head Wrightson; H. E. Badland, foreman moulder, Qualcast, Limited; T. Brooke, rate fixer, English Electric Company; F. Brown, analytical chemist, Coltness Iron Company; A. H. Burton, foundry foreman, Harrison & Company; J. G. Carrey, iron and steel moulder, Blairs, Limited; T. Craig, foreman moulder, Darlington Forge; R. A. Creasey, coremaker, Harrison & Company; N. Hurst, foundry operative, Pepper Mill Foundry; F. G. Lloyd, ironmoulder, 10-11, Elm Street, Cardiff; A. Lomas, assistant foreman annealer, Ley's Malleable; J. Peers, assistant foreman, Ley's Malleable; T. Speirs, foundry foreman; A. Steel, annealing foreman, Harrison & Company; S. E. Wilford, loam moulder, Worthington Simpson; S. M. Beck, laboratory assistant, Ley's Malleable; J. R. D. Kirby, journeyman moulder, Coltness Iron Company; A. H. Blofield, assistant metallurgist, Crane, Limited; W. L. Bolton, apprentice metallurgical chemist, Hepworth & Grandage; J. W. S. Darnborough, assistant foreman, Darlington Forge; T. C. Daw, foreman moulder, Central Engineering Works; G. H. Dyson, assistant foreman moulder, D. Brown & Sons; H. Flavell, engineers' buyer, Herbert Morris, Limited; W. G. P. Harris, metallurgist, International Alloys; T. Jennings, patternmaker, Hargreaves & Jennings; H. Marshall, foreman, Darlington Forge; A. Senior, foreman patternmaker, Darlington Forge; F. Swift, Junr., foreman moulder, Darlington Forge; W. Thomas, foundry foreman, Seagers, Limited; J. H. Witham, foundry foreman, Tonge & Taggart; C. Booth, mechanical moulding foreman, English Electric Company; T. C. Hadley, foundry foreman, S. H. Russell & Company; J. L. Younger, foundry charge-hand, R. A. Lister & Company; J. N. Sherar, draughtsman, Farrar, Limited, R. C. J. Wilson, steel moulder, Newman Industries, Limited.

Associates

W. G. Calder, metallurgical apprentice, Glenfield & Kennedy; W. Dixon, apprentice brass moulder, G. & J. Weir, Limited; J. R. Dowson, apprentice, Wolsingham Steel Company, Limited; J. R. Herdman, apprentice chemist, Wolsingham Steel Company, Limited; H. P. Millar, metallurgical apprentice, Glenfield & Kennedy; J. G. Ogilvie, apprentice patternmaker, G. & J. Weir, Limited; A. P. Scattergood, laboratory assistant, Qualcast, Limited; J. Newland, patternmaker, Central Engineering Works, Johannesburg; R. Corbett, laboratory assistant, J. Harper & Company.

ESTIMATION OF SULPHUR AND PHOSPHORUS

The First Report of the Standard Methods of Analysis Sub-Committee of the Committee on the Heterogeneity of Steel Ingots has recently been published by the Iron and Steel Institute. The members of the Sub-Committee recommend methods that they have devised, from both theoretical considerations and practical experiments, for the determination of sulphur and of phosphorus in carbon steels.

The recommended method for sulphur is a refinement of the gravimetric aqua-regia/barium-sulphate process, and for the determination of phosphorus the Sub-Committee recommends a modified bromide process, whereby arsenic is eliminated prior to the precipitation of the phosphorus as the yellow precipitate, in view of the fact that practically all commercial steels contain arsenic.

Precise details are laid down regarding analytical procedure, and notes are appended drawing attention to the precautions needed to ensure reproducible results within the specified degree of accuracy expected when all practical instructions are rigidly adhered to.

In the case of both elements, the Sub-Committee is unanimously of the opinion that the recommended methods cannot be expected to yield consistent results closer than $\pm$ 0.0015 per cent. of the true sulphur and phosphorus contents of the steel.

It is emphasised that the methods recommended were devised primarily for "referee" purposes, and, therefore, little cognisance was taken of the time or expense involved in the determination of either element. The main object was to devise standardised processes yielding comparable results when carried out by different chemists using the same samples of steel.

The Report concludes with a recommended method for the determination of lead in steel. This method, based on the initial separation of the lead as lead sulphate and its subsequent conversion to lead molybdate, was subjected to rigid examination and experiment, and remarkably close agreement was obtained.

RECENT DEVELOPMENTS IN SAND TESTING*

COMPARATIVE SURVEY OF BRITISH AND AMERICAN INVESTIGATIONS

By Wm. Y. BUCHANAN

(*Continued from page* 34.)

Ramming

On the question of ramming, Dr. Ries said in his 1941 A.F.A. report that "there is no more widely-used steps in clay testing than preparation of specimen by ramming." It might be added that if there is any defect in this fundamental part of the procedure, the whole structure of sand testing simply falls down. The only defect that is referred to in the Report is that which can be caused by lack of mass or foundation in the pedestal on which the rammer is set or the inefficient absorption of the force of the blows due to the lack of solid contact between the rammer and the base.

It is interesting to recall that Dr. Skerl pointed this out to the Institute Committee about 1933, but the point was not deemed worthy of serious consideration by the committee at that time, while lately it has been, to the author's mind, where testing is done in a laboratory, given too much prominence, since it is, of all possible defects, the least important and could quite well have been given attention last. It is far more important to provide for the tube moving with the third blow in an effort to produce a test-piece uniformly rammed.

The other defect, which the author demonstrated, was that the A.F.A. test-piece was too short to give the correct compression, and he thought that it would in the circumstances be better accepted with the best grace, because this was the only suitable type of test-piece which can be rammed in the present standard A.F.A. rammer, while the index of ramming method, which the author has suggested should be added to the A.F.A. procedure, can be even more easily applied to this short test-piece.

On the other hand, the A.F.A. rammer could not ram a properly-designed test-piece, *i.e.*, one in which the length is twice the diameter. This proposal was put before the Institute's Committee about 1934, and the author made a report on the results, a considerable amount of work being done at the time.

* Paper read before the Scottish Branch of the Institute of British Foundrymen.

Test-Piece Size

In recent American research work, the making of a test-piece 2 in. dia. by 3.55 in. long has been suggested, but this test-piece is getting too large, and there must be a limit to the size of test-piece which can be conveniently used. Most apparatus now in existence cannot accommodate a test-piece this size, and it seems to have no inherent advantage other than the length to diameter ratio, which is better for compression test than the existing 2-in. by 2-in. standard American test-piece.

This 2-in. by 3.55-in. test-piece is made by allowing the tube to move downwards with each blow in order to obtain uniform ramming. Under this condition, of course, the degree of ramming is considerably different from the existing method where the tube is stationary during the three blows.

Whether the test-piece, $1\frac{1}{8}$ in. dia. by 2 in. long, can be rammed satisfactorily in the A.F.A. rammer is doubtful. This suggestion was put forward to the Institute's Committee by Richardson in 1932, and the present author carried out a good deal of work which showed that it could not be done with the A.F.A. rammer and a stationary tube, *i.e.*, by the present standard practice, because flowability affects the making of this test-piece much more seriously than it does the 2-in. by 2-in. test-piece.

This recent American research now increases the number of test-pieces to the following list:—

(1) The standard A.F.A. test-piece, 2 in. by 2 in. dia., with stationary tube.

(2) The standard B.C.I.R.A. test-piece, $1\frac{1}{8}$ in. by $2\frac{1}{4}$ in., made by double compression.

(3) The A.F.A. suggested test-piece, 2 in. by 3.55 in., made by allowing the tube to move downwards with each blow.

(4) The test-piece made in the A.F.A. rammer, $1\frac{1}{8}$ in. dia. by 2 in. long, with the tube moving downwards with each blow.

The decision as to which type of test-piece is most desirable should be settled immediately and the means of making it in an evenly-rammed condition could perhaps be accomplished with less trouble. It is certain, however, that whichever test-piece be adopted, the Index of Ramming method can be applied and the making of the test-

piece by compression accomplished without trouble, at the same time producing a uniform degree of ramming throughout its length.

Tests under Investigation by the A.F.A.

Sintering Test.—This test has evidently not been much used and a programme of investigation to improve the test has been initiated.

Core Hardness.—The method recently evolved by the A.F.A. Committee appears to be a modification of the Dietert hardness tester and consists of a hard metal plough which protrudes through a slot in a plate, which when drawn across the surface of the core produces a scratch the depth of which measures the hardness of the core.

The method which the author devised was put before the Institute Committee several years before this (about 1934), one which has been used extensively by the author for research on the construction of diagrams showing the distribution of hardness in standard specimens. This consisted of a loaded drill which can be constructed very cheaply and is very easy to operate on small surfaces.

Durability and Flowability.—The report goes on to say that durability and flowability are two properties for which no test has yet been recommended by the A.F.A. Committee. Both represent important problems not yet satisfactorily solved. Sub-committees have been appointed to study them.

A "durability" test is perhaps not likely to be very commonly used and it is probable that the majority of foundrymen will be content to leave this to the few larger research establishments. This is a test in which some of the early workers were interested, but as it usually involved some method of repeated casting in the sand sample it has not been developed on the lines of the simple permeability or strength tests.

In the case of flowability, here again the author put forward a simple method about 1934, which was apparently before its time as the subject has not been considered yet. There was also a published account of considerable work on the problem by Kyle in the A.F.A. Proceedings.

III—EFFECT OF HIGH TEMPERATURES ON STEEL SANDS

The progress report on investigations of the effect of high temperatures on steel sands, included in Dr. Ries' report, consists of three main sections: (1) Expansion—contraction tests; (2) comparison of specimen sizes; and (3) measurement of free expansion of sand mixtures at high temperatures.

COMPARISON OF TEST-PIECE SIZES

By J. R. Young, Ithaca, N.Y.

This is a very lengthy series of tests to study the results from 2-in. by 2-in. A.F.A. test-pieces and a test-piece 1½ in by 2 in. rammed with a special drop weight, in order to check the conclusions in the present author's previous Papers which showed that the A.F.A. 2-in. by 2-in. test-piece was too short to give a true measure of bond strength in sand. In this work, the terms double-end ramming and single ramming as introduced in the author's early work are adopted. It is, of course, very necessary to use double-end ramming for a test-piece 1½ in. dia. by 2 in. long in the A.F.A. rammer.

A summary of the results of this test work and the conclusions that may be drawn from the data acquired are as follow:—

Room Temperature Comparisons

(1) The room temperature properties obtained with 2-in. by 2-in. specimens rammed by the standard A.F.A. method are considerably different from those obtained for corresponding 1½-in. by 2-in. specimens rammed with the Dietert rammer. (*a*) 1½-in. by 2-in. specimens have consistently greater green apparent densities than the 2-in. by 2-in. specimens. (*b*) 2-in. by 2-in. specimens yield considerably higher permeability numbers than do the 1½-in. by 2-in. specimens. (*c*) 1½-in. by 2-in. specimens show higher green and dry strengths than the 2-in. by 2-in. specimens. (*d*) 2-in. by 2-in. specimens give higher deformation values than the 1½-in. by 2-in. specimens.

(2) The extent to which the results of 2-in. by 2-in. and 1½-in. by 2-in. specimens differ depends a great deal on the sand being tested. For some sands 2-in. by 2-in. and 1½-in. by 2-in. specimens give almost identical data, whereas for other mixtures the results obtained with 1½-in. by 2-in. specimens are not at all comparable to those given by 2-in. by 2-in. specimens. The extent of the difference in results is affected considerably also by a change in moisture content of any particular sand.

(3) There is apparently no formula for converting results obtained from 1½-in. by 2-in. specimens into figures which would hold true for corresponding 2-in. by 2-in. specimens.

(4) It has not been found possible to bring 1½-in. by 2-in. and 2-in. by 2-in. specimen results into agreement by changing either the amount of energy imparted to the specimen or the length: diameter ratio of the 2-in. by 2-in. specimen.

(5) If 1½-in. by 2-in. specimens are made of equal green apparent density to corresponding 2-in. by

2-in. specimens, or *vice versa*, the results given by the two sizes of specimens do not agree.

(6) It is suggested that the results given by a 1¼-in. by 2-in. specimen might be made to resemble more closely those given by 2-in. by 2-in. specimens by changing certain conditions of ramming. However, it is not probable that the two sizes of specimens can be made, by any method of drop-ramming, to agree in all room temperature test properties.

(7) Evidence points to the fact that 2 in. dia. specimens ram more uniformly by the ordinary drop-weight method than do 1¼ in. dia. specimens.

High-Temperature Comparisons

(8) Comparing 2-in. by 2-in. specimens rammed by the standard A.F.A. method with 1¼-in. by 2-in. specimens of the same sand rammed with the Dietert rammer, the following are found to be true:—(*a*) 1¼-in. by 2-in. specimens give higher true hot strengths than 2-in. by 2-in. specimens; and (*b*) there is substantially no difference in the amount of free expansion shown by the two sizes of specimens, provided there is no evidence of cracks in either specimen.

(9) The 1¼-in. by 2-in. specimens may be heated at a more rapid rate without cracking than 2-in. by 2-in. specimens. Likewise, dried sand specimens crack less on shock heating than green-sand specimens.

(10) It is necessary to heat specimens of any size at a slow enough rate to ensure absence of cracks if true hot-strengths are desired, even though it is possible closely to duplicate results obtained from slightly cracked specimens. The same would apply for expansion tests.

(11) The safe heating rate depends on the character of each particular sand mixture. Some sands crack when their temperature rises as slowly as 3 deg. C. per min., while others withstand sudden exposure temperatures approaching their fusion points.

(12) On careful thought, it would appear that 1¼-in. by 2-in. specimens possess the more desirable dimensional ratio for test purposes. Although the standard 2-in. by 2-in. specimen has proved itself of value for foundry control testing, it might be found that a somewhat longer 2 in. dia. specimen would yield more consistent results.

(13) Even commercially successful foundry sands do not necessarily show absolute freedom from cracks on shock heating. However, it has been found that those sands which do not crack on shock heating produce more satisfactory casting-surface finish. Since the work for this Report was completed, further correlations have been made between the behaviour of specimens of moulding sands in the high-temperature furnace and the action of those same sands under casting conditions. It might be of interest to note here that, as a result of the tests run in conjunction with this Report, a change was made in one of the grey-iron sand mixtures tested. This improvement resulted in better casting finish and a considerable decrease in losses attributable to poor sand. In another case, where the frequent occurrence of fins on a smooth rounded surface of the grey-iron casting had been reported, it was possible to show by the behaviour of specimens at high temperature that such a condition would be favoured by the use of the existing sand mixture.

(14) Because of the considerable difference in the test properties of 1¼-in. by 2-in. and 2-in. by 2-in. specimens, it does not seem logical to use information obtained from one size specimen tested at high temperature to apply to another size specimen tested at room temperature. Either there should be no attempt made to correlate room-temperature and high-temperature test properties of a particular sand, or the same size specimen should be used for both fields of testing.

(15) It is difficult to state with any degree of certainty whether either the 1¼-in. by 2-in. specimen or the 2-in. by 2-in. specimen is the better for sand testing, whether at high or room temperatures. It may be that both sizes of specimens have their own individual applications.

Discussion of Conclusions

The conclusions set out in this Report are in more or less complete agreement with the author's findings both unpublished and those published in the "Foundry Trade Journal." But they do not refer to the consideration of variation of hardness of ramming resulting from different methods of applying the ramming forces; for example, diagrams are published in the author's previous work showing distribution of hardness throughout the section of an A.F.A. standard test-piece rammed with some movement of the tube during ramming and an A.F.A. test-piece rammed by double compression. These aspects of the subject should be considered when the test-piece is finally selected from the four types now under consideration.

It is also interesting to note that the introduction of the Report contains the following statement:—*

* Later news from America amends this statement by the addition of the following paragraph. "By letter ballot, the Executive Committee of the Foundry Sand Research Committee voted approval of the 1¼ in. x 2 in. specimen for elevated temperature testing of foundry moulding sands, etc."—Editor.

"As a result of this work, at a meeting of Sub-Committee 6b7, in New York on February 19, 1941, a motion was passed unanimously to recommend to the Executive Committee of the Foundry Sand Research Committee that the 1¼-in. by 2-in. specimen be approved as tentative standard for the elevated temperature testing of foundry moulding materials with the understanding that the motion did not exclude the use of other sand specimen sizes for that purpose." This seems a step in the right direction.

THE MEASUREMENT OF FREE EXPANSION

By G. W. Ehrhart

In this section of the Ries' Report, Ehrhart deals very carefully with actual methods and possible errors. The present author started this phase of sand testing mainly to check over some published conclusions and recommendations set out by Hudson in his Papers on the subject to the Institute. The apparatus used by the author has been illustrated and described in the "Foundry Trade Journal," and it was pointed out that the measurements were made with extreme care and elaborate duplicating as the hitherto-published results were difficult to reconcile with everyday observation and practice.

The author is unable to understand why the American research workers found it necessary to construct a gas-heated furnace as the electric horizontal furnace used by the author was evidently very accurate and convenient. Ehrhart found trouble with the rods whether of quartz, alundum or globar, due to warping presumably, while using Dietert's vertical electric heated furnace. If these rods were of considerable length or of relatively small cross-section, it is possible that this warping would take place.

Nature of Expansion

The author drew attention to the fallacy in previously published conclusions that expansion as represented in these graphs reflected expansion in the mould during casting and pointed out that this test or measurement gave what was essentially free expansion which never existed in a mould face. This comment has evidently been carefully noted in America, because even in the case of Dietert's vertical furnace which has the rods resting vertically on the top of the test-piece, the conditions of the test are said to be restricted expansion.

However, the author used dried specimens and the force exerted on the test-piece by the measuring dial and rods only amounted to 2 ozs., hence it is claimed that the author's work can be referred to as truly free expansion, as stated at the time. The author's readings were taken so frequently that the points formed a continuous line throughout the graph, and a remarkable reproduction of the main characteristic was observed in hundreds of these graphs.

It is interesting to note that the author's curves referred to in moulding sand fit almost exactly to the graphs showing in Fig. 16 of Ehrhart's Paper, with the exception that the softening and/or contraction of the bond material apparently takes place at a much higher temperature. The curves found in the earlier published work are apparently not based on very many readings, with the result that they jump about in an unconvincing manner.

Ehrhart's method of measurement is entirely different, being based on optical methods of measurements with the object of eliminating the use of silica rods altogether. The Report clearly illustrates the method and lists the complete details of expansion measurement, etc.

Ehrhart's Results

The results of Ehrhart's free expansion-contraction investigation, for the mixtures tested, may be summarised as follow:—

(1) Total expansion was independent of amount of bond, moisture and degree of ramming. (2) Total contraction was less than total expansion. (3) Total contraction is less for fireclay-bonded mixtures than for bentonite bonded mixtures. (4) Curiously enough, it was observed that the contraction was greater when cracking took place. (5) When the rate of heating was slow enough to prevent cracking, there was no difference in the expansion-contraction of 1¼-in. specimens.

(6) The 1¼-in. specimens could be heated at a faster rate than the 2-in. specimens, without cracking. (7) On reheating a specimen, the expansion was found to be less than on the first heating. (8) On reheating, the specimen contracted to very nearly the same length as before reheating.

(9) If a specimen which has been previously heat-tested be broken up, tempered without addition of new bond and made into a new specimen, the expansion will be the same as that found for the original specimen on the first heating.

(10) If new sand, without bond, be heated and cooled at rates equal to those used for testing specimens, then bonded, tempered and made into specimens, the expansion-contraction will be the same for the untreated sand.

Recent Developments in Sand Testing

It should be noted here that statements 9 and 10 both contradict Hudson's conclusions.

Author's Comment

In the high temperature work carried out by the author, the test was completed in about 1 hr. The average rate of heating to 600 deg. C. was 18.7 deg. C. per min., or the average rate of 14.3 deg. C. per min. up to 1,000 deg. C., without any sign of cracking whatever on the moulding sand tested, *i.e.*, the floor sand consisting of Scottish rock sand originally. These specimens were standard 2½ in. by 1⅛ in. dia. made by double compression to a fixed Index of Ramming figure, and they were all dried before testing for expansion so that no plates were required between the ends of the test-piece and the ends of the silica rods which were ⅛ in. dia, and well supported horizontally, and certainly showed *not the slightest sign* of distortion.

Furthermore, the expansion of the rods alone through the test range of temperature was found to be uniform and regular in duplicate test. An example of the free expansion figures obtained were 0.011 in. per in. maximum for floor sand, with 0.013 in. per in. maximum for floor sand with a coal dust addition. On the other hand, Ehrhart using his gas furnace had to reduce the rate of heating to 4 deg. C. per min. up to 100 deg. C. in order to prevent cracking.

Other aspects of the subject to which the author has referred in previous work and which are so far not been dealt with in America or here are as follow:—

(*a*) Conductivity of sands at high and low temperatures.

(*b*) Specific heat of sands at high and low temperatures and the effect of composition thereon.

(*c*) The effect of atmosphere on expansion at high temperatures.

(*d*) The effect of atmosphere on strength at high temperatures.

(*e*) The effect of restriction on expansion in addition to and apart from above-mentioned properties or combinations of them.

Everyone is familiar with the idea of the pressure exerted by expanding liquids such as water or by such solids as steel. Bonded sand, however, is not a homogeneous material, and the sequence of changes alone makes its behaviour during expansion unique. In addition it is possible for silica sand grains to expand within the sand itself.

As a result of early work, some foundrymen actually began speaking of the expansion of sand as equal to ¼ in. per ft., as though it were as commonplace in normal foundry practice as the use of the patternmaker's contraction rule!

IV—STEEL SAND MIXTURES

By H. Ramsey

Another article on the same subject is that by H. Ramsey in the October, 1941, issue of "The Foundry." It contains some questions which the author has frequently asked to be given consideration in the Institute. The question of whether the standard rammed test-piece represents the foundry conditions or not is one which has never been properly answered, and a clearer idea of the advantages and shortcomings of ramming system should be constantly kept before thus using sand testing.

The whole question may be and has been considered as parallel to the testing of castings by separately-cast test-bars. Some foundrymen already thought in the early days that the separately-cast test-bar was often unrepresentative of the casting, but this aspect was considered unimportant because the difficulties of cutting up castings in order to obtain actual test samples of the material were considered insuperable. The argument at the time was that the difference between separately-cast test-bars and actual sections from the castings would be readily recognised by all concerned.

However, recently much misunderstanding has been caused among engineers by the fact that many high metallurgical claims are made for special irons, claims which are based on the results from separately-cast bars, whereas the result in the castings themselves are invariably disappointing. The same argument might, therefore, apply in the case of sand testing, and some means of varying the degree of ramming of the test-piece, to cover the range in moulding, should this be required, is highly essential.

In his article Ramsey writes that "a great deal has been said and written on steel foundry sands and sand mixes during the past ten years, but when the facts are faced little practical progress seems to have been accomplished. True, there is a little more sand control. Measuring and mixing of sands and binders are watched more closely, but the check of present-day mixes with those used ten years ago indicates the majority are almost if not actually the same.

Different Sands are Used

"Even with testing and research work all do not yet agree on the correct sand to use. The

Recent Developments in Sand Testing

author was interested recently in seeing some data accumulated from a questionnaire giving information on green-sand facings. Twenty sands were reported, and the average fineness varied from 26 to 71. The grain shape varied from angular to sub-angular to round. The uniformity of the grain size varied from one extreme to the other. The water content for the green-sand facings varied from 2.5 per cent. to 4.5 per cent. The permeability varied from 100 to 250. The strength varied from 3.9 to 8.0. There is certainly no consistency in those figures. It was the same ten years ago, and ideas seem to be no closer together than at that time.

"As far as tests and methods of testing are concerned, results from one shop to another still cannot be compared without running into the danger of error. One reason is that, while sand specimens are rammed with three blows of the rammer, all do not have the same foundations under the rammer machine. Some use concrete foundation, some wood, and even in some cases just a dirt floor. A difference in the foundation under the rammer will make a difference in the permeability and strength readings of as much as 30 per cent. Therefore, in comparing results from shop to shop, this foundation matter must be taken into consideration."

Enlarging on this matter of ramming, the author is not so sure that it is correct to set a standard of always using three blows on the sand specimen. It is well known that some facings are easier to ram than others. That being the case, the sand that is easiest to ram will show a lower permeability, because it will pack tighter under three blows of the rammer. In actual shop practice, a mould is rammed to a certain hardness regardless of the number of blows required on the jolt machine or by the air rammer—therefore, should not the sand specimens be rammed to a certain hardness no matter how many blows are required for a true comparison of permeability and strength.

Test Conditions Vary Results

Under the system of always using three blows with the rammer, a sand with an extra addition of flour or bentonite often can be made to show a higher permeability, for the simple fact that the extra addition of these bonds gives a softer and, therefore, more open specimen. If the two specimens were of the same hardness, the one with more bentonite or flour would have the lower permeability.

RAPID DETECTION OF NICKEL IN STEEL

Mr. T. H. Williams, in "Industrial and Engineering Chemistry," describes a method developed to meet the need for a rapid and non-destructive method for differentiating gears containing 1 to 2 per cent. of nickel from gears made of plain carbon and molybdenum alloy steels. The test employs dimethylglyoxime as indicator, and a special feature of the procedure recommended is the use of a mixture containing sulphuric, phosphoric, nitric and citric acids, which eliminates the need for preliminary separation of interfering ions, and the difficulties associated with such separation.

The following procedure has been found to fulfil all requirements:—

Reagents and Procedure.—Acid Mixture: 25 ml. of distilled water; 10 ml. of sulphuric acid, specific gravity 1.84; 10 ml. of nitric acid, specific gravity 1.42; 10 ml. of phosphoric acid, 85 per cent.; and 10 grammes of citric acid crystals.

Potassium hydroxide: 30 grammes of KOH and 90 ml. of distilled water.

Dimethylglyoxime, 1 per cent. in isopropanol.

Test Papers.—Strips of filter paper dipped in a solution containing 10 grammes of citric acid, 25 ml. of distilled water, and 10 ml. of 1 per cent. dimethylglyoxime in isopropanol. Strips are thoroughly dried and can be kept in stoppered bottles. One drop of the acid mixture is placed on the steel and allowed to react for 15 to 30 sec. This solution is then absorbed on a paper test strip and 2 to 3 drops of KOH solution are poured over the spot. If nickel is present an unmistakable red colouration will appear, its intensity increasing with an increase in percentage of nickel present.

The absence of nickel is indicated by an almost total absence of colour on the test strip. Any noticeable colour that might occur will be distinctly brown ($Fe(OH)_3$) and cannot be confused with the red nickel dimethylglyoxime precipitate. Tests on a series of steels of low-, medium- and high-nickel content showed the method to be specific and accurate for identification of nickel. No questionable or interfering colour reactions from elements other than nickel were observed in any case investigated.—"Nickel Bulletin."

ETCHING TECHNIQUE

(*Concluded from page* 57.)

question, because an insoluble precipitate of fine crystals of cuprous chloride forms in a haphazard manner and obstructs the view. For this reason the ferric-chloride reagents always carry some hydrochloric acid, and this immediately puts them in the class of violent etchants, to be used skilfully and rapidly, without any chance of obtaining more information by prolonged etching. It is well known that the etching of nickel and its alloys is considered a difficult task. Scores of reagents were offered, and some seem to have given good results if skilfully used in specific cases.

ETCHING TECHNIQUE

Three Main Groups of Reagents

Discussing etching technique in an article in "Steel," M. G. Corson suggests that it might be desirable to consider what requirements a good etching medium must satisfy. Needless to say it must reveal a structure that is pleasing to the eye—this is the first and almost only way of approaching an etched surface. The picture which the metallographer intends to examine must be clear, clean, contrasting, and to a great extent should show exactly what he intends to see. Besides it must be obtained fairly rapidly.

Etchings that fulfil these requirements are well known for the majority of industrial metals and alloys. Excellent pictures can be secured of pearlitic or martensitic steels using picral of almost any concentration. On the other hand, most of the etchants suffer from the defect of being uncontrollable. A short dip followed by good washing and drying produces a good etch if skilfully executed. However, if the metal is etched for a fraction of a minute longer the section must be repolished, because the features become blurred and in many cases pitted as well. Of course, most of the pits are not pits at all, but small pyramids which remained because they were protected by gas bubbles while the metal around was being etched away. Besides, the beautiful picture which is seen after a skilful but short etch is rarely telling the whole story. Sharp and clear as it is, it does not reveal a number of features which require a long etch. And the majority of etchants, especially those containing hydrogen ions, do not permit a prolonged etching at all.

Grouping of Etchants

In general the existing etching reagents can be sub-divided into three groups, namely: (1) Those where the etching effect is due primarily to their content of hydrogen ions. (2) Those where the etching depends upon the hydroxyl ion. (3) Reagents producing a differential staining effect, the chemical nature of which is still most obscure. To this group belong the picrates used to darken iron carbide in steels, the ferricyanides used to differentiate between various carbides, etc.

The reagents of the first two groups might be expected to produce pictures consisting strictly of sharp lines, *i.e.*, grain boundaries, twinning trace lines, outlines of secondary constituents, and inclusions. Sometimes they actually do just that; however, in the majority of cases they produce a staining effect in addition. The metallographer is inclined to describe the result as fine pearlite, sorbite, troostite, bainite, martensite in steels; or, when the beautiful staining effect is obtained in brasses, aluminium bronze, silicon bronzes, etc., the visible grains are called "polyhedra"—as if etching were capable of bringing out each granule in relief—showing its outer surfaces, not merely cross-sections.

The fact is that all these beautiful shadings, etc., are merely stains properly placed by the etchant upon the surface of the sample. A slight repolishing on velvet, using a dilute solution of soap with no abrasive at all eliminates these stains entirely, leaving behind mere outlines. Again, in the case of copper-base alloys of the alpha type, etching with ammonium persulphate solutions produces only outlines, while etching with acid ferric chloride or chromic acid will immediately produce "polyhedra."

It is by no means implied that these staining effects are undesirable. For, no matter what the æsthetic effect, every staining is caused by the specific character of the region stained. Even a stain produced due to disturbed metal is important, because it reveals the latter's presence. And, if a stain continues to reappear after many repolishings, mechanical or electrolytic, it points out definitely some local discontinuity, and should be studied thoroughly instead of being discarded for its ugliness and lack of agreement with preconceptions regarding the nature of the structure expected.

Reduction in Number

It might be too presumptuous to try and offer ideas leading to some universal etching solution. Such hardly can be found. However, it is worth while to reduce the huge number of etchants published to just a few, chosen on the basis of chemical logics, not a mere "hit and miss" idea.

Among all the etchants possible there is a great number that should be called "violent." In fact most of them are violent. Even an alcoholic solution of picric acid is violent and will produce a black blur unless handled skilfully. A solution of hydrochloric acid will etch steel well enough if acting for a fraction of a second, otherwise it will pit the sample so badly as to call for a re-grinding on paper No. 1, etc., etc.

A non-violent etchant is one whose action is not accompanied by any development of gases. This implies a reaction of a straight transfer between the etchant and the metal. And such reactions depend exclusively upon the lowering of valency of some element present in the etching solution. It is noted that reagents of this kind are never highly ionised, and the ionisation can be even further reduced by using a proper solvent. Therefore, their action is slow and can easily be controlled. In certain cases the etching action may be allowed to go on for hours and even days, continuously revealing new structural details—not new phases, merely more delicate features of phases already known.

Ferric Salts of Iron

The most accessible reagents which act by changing their valency are the ferric salts of iron. There are the chloride, bromide, iodide and fluoride in the first line; nitrate and sulphate in the second. The first four are quite soluble in water, alcohol, glycol, glycerol, even in ether, and their action is very simple: one quite mobile ion of a halogen is taken away by the metal to be etched.

It might be said that ferric chloride is by no means a new etchant. That is true. However, it has been used mainly for copper-base alloys. And, here the use of a straight ferric-chloride solution is out of

(*Continued on page* 56.)

TREATMENT OF POROSITY IN HYDRAULIC CASTINGS

By R. C. DYER, Works Metallurgist of a London Foundry

Under wartime conditions the ironfounder of to-day has often to produce at short notice castings which, due to varied factors, would normally take a considerable time to produce. Under such conditions it is possible, that on account of slight porosity, some of the castings will not be up to the standard required. Although, due to reasons of time, it may be very difficult to remove all the causes of the trouble, there is still some work that may be done by dealing with these castings.

A firm recently had a number of castings to produce quickly to a set specification which had to withstand heavy hydraulic pressure. It was considered at the outset of production that there were several factors that might give trouble from the point of view of hydraulic efficiency in the finished casting. Steps were taken to minimise these, but owing to the urgency of the work it was decided to conduct research on the problem of treating the castings if any failed under test.

The author has always viewed certain usual methods with some distrust. First, actual results showed that they were rather "hit and miss," whilst, secondly, the future behaviour of the seal was rather uncertain. In other words, the casting might pass the actual test only to give trouble at some later date in service. Some method of treatment was desired that would give a service of predictable efficiency.

At the time of the problem a certain amount of data had been produced by the Americans on the use of synthetic resins for this purpose. Very little detail was available, however. The resin had to be water resistant, infusible, of the thermohardening type for preference, and in liquid form for ease of introduction into the porosity.

Procedure Adopted

The treatment adopted in the particular case under consideration was as follows: On locating the porosity the area was drilled half way through with a small bit. A nipple was screwed in, the liquid resin injected under pressure and the hole then plugged. Having saturated the porosity, the casting was placed in a corestove overnight in a temperature in the region of 200 deg. F. (Slight variation from this figure had no harmful effect.)

The actual resin used was "Epok Resin R 506/60." This resin is supplied in alcoholic solution, but another resin of similar physical characteristics is supplied in aqueous solution. On curing, these solutions thermoharden to give a solid of the following properties: (1) Brinell hardness, using a 2.5-mm. ball and a 25-mg. load, 30 to 45; (2) tensile strength, 5,000 to 8,000 lbs. per sq. in.; (3) coefficient of thermal expansion, 0.3 to 0.5 by 10^{-5} per deg. C.; and (4) it was infusible and unaffected by water or organic solvents.

The casting treated had on first test leaked at 50 lbs. per sq. in. After injection (the area on both sides of the porosity being smeared with the solution as an added precaution) and curing, the resin hardened to give a tough film. The casting was then tested again and a figure of 300 lbs. pressure reached without any trace of leak. In view of this, and the fact that the filling was of known efficiency, the customer accepted the casting, and it is now known to be performing satisfactorily in service.

It will be appreciated that many castings that have to withstand hydraulic pressure are made from iron because they form a unit of a metallic whole which requires strength in its component parts. That is, to reject an iron casting on account of slight porosity at some point (provided that porosity can be filled to give hydraulic soundness) is a waste of time and material, both of which are so essential at the present moment. It is hoped that the above data will prove of use to other ironfounders who come in contact with the same problem.

PERSONAL

MR. L. REEVES, after nine months as locomotive works manager for the L.N.E.R. at Darlington, has been appointed mechanical engineer for the company in Scotland and will take up his new duties at Cowlairs.

SIR AMOS L. AYRE has been elected an Honorary Fellow of the North-East Coast Institution of Engineers and Shipbuilders in recognition of his distinguished work in connection with shipbuilding and its associated trades.

MR. RAMSAY GEBBIE, managing director of William Doxford & Sons, Limited, the Sunderland shipbuilders and engineers, has succeeded Mr. W. A. Woodeson as president of the North-East Coast Institution of Engineers and Shipbuilders.

MR. G. H. WILSON has been elected chairman and managing director of Laurence, Scott & Electromotors, Limited, in succession to the late Captain G. J. Scott. Mr. Wilson, who joined the company in 1919, has been a member of the board since 1922. Mr. E. Pinckston and Mr. F. Lee have been appointed to the board of directors.

MR. EDGAR G. REES, of Llanelly, the new president of the National Federation of Iron, Steel and Metal Merchants, has for several years been a leading figure in Welsh industrial circles, and since the war has been Area Officer for South Wales and the West of England for the Ministry of Supply, Iron and Steel Control. Mr. Rees is president of the South Wales and Monmouthshire Iron, Steel and Tinplate Merchants' Association, and a member of the Council of the British Shipbreakers' Association.

Wills

MACLELLAN, C. S., of Glasgow, a former vice-chairman of P. & W. MacLellan, Limited, engineers ... £65,253

BARWELL, C. H., of Kenilworth, chairman of Charles Clifford & Son, Limited, metal rollers, and of Metallisation, Limited £17,466

ROBERTS, W. N., of Leeds, managing director of J. W. Roberts, Limited, and a director of Turner & Newall, Limited, asbestos manufacturers ... £114,831

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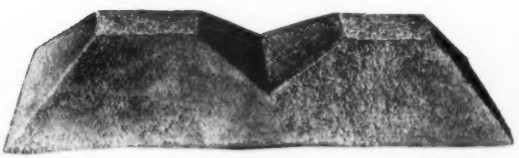

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NEWS IN BRIEF

CANADIAN WAR DEMANDS now take upwards of 90 per cent. of all steel produced in Canada.

THE BRAZILIAN GOVERNMENT has authorised the exportation to the United States of 200,000 tons of manganese.

THE LONDON OFFICES of the Butterley Company, Limited (engineering section) are now at 2, Caxton Street, London, S.W.1.

THE LONDON OFFICE of Petters, Limited, has been transferred from Bush House, Aldwych, to Surrey House, Victoria Embankment, W.C.2.

THE ADDRESS of the National Federation of Scrap Iron, Steel and Metal Merchants is now Wellington House, 125-130, Strand, London, W.C.2.

CANADA IS PROPOSING to divert some of its hydro-electric power at present devoted to the manufacture of newsprint to increase its output of aluminium.

THE UNITED STATES has transferred 2,098,560 tons of iron and steel under lend-lease provisions up to February 28. The non-ferrous metals totalled 203,524 tons.

MR. A. W. HUNTER, 185-188, High Holborn, London, W.C.1, has been appointed liquidator (with a Committee of Inspection) of Newman Engineering, Limited.

PORT GLASGOW SHIPYARDS and engineering shops are to fall into line with other Clyde establishments which for several years have recognised Friday instead of Saturday as pay day.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, Loughborough, have moved their London office from Bush House, Aldwych, to Surrey House, Victoria Embankment, W.C.2.

U.S. BUREAU OF MINES reports that estimated consumption of mercury in 1941 at 44,800 flasks of 76 lbs. each. Production was 44,000 flasks. In 1940 there was a large exportable surplus.

PRESIDING at the annual meeting of Federated Foundries, Limited, Mr. William Rennie said that loss of sales had continued to affect the company adversely. The directors were taking every step to secure additional business by adapting their foundries to other work.

"MODERN METHODS OF PROTECTION FROM CORROSION" is the title of an address to be given by Dr. T. P. Hoar at a meeting of the London Local Section of the Institute of Metals to be held at the Junior Institution of Engineers, 39, Victoria Street, London, S.W.1, on Thursday, May 21, at 6.30 p.m.

AMERICAN OUTPUT OF STEEL INGOTS and castings in February was the second highest on record. Average weekly production, 1,631,278 net tons, was only 0.25 per cent. under the all-time peak in October, 1941, according to the American Iron and Steel Institute. Weekly output in January averaged 1,609,334 tons. Total production in February was 6,525,111 tons, compared with 7,129,351 tons in January. During February the industry operated at 96 per cent. of capacity, against 94.7 per cent. in January.

VALUE OF SCRAP TO THE NATION

A meeting of the National Federation of Scrap Iron, Steel and Metal Merchants was held at Cardiff recently, when Mr. Edgar J. Rees, of Llanelly, was installed as President. Mr. Rees said that people failed to realise that the basic raw material for the manufacture of guns, ships and tanks passed through the hands of the scrap merchants of the country. The railings and national survey scrap now being recovered had to be properly graded and cut to sizes suitable to the requirements of foundries, steelworks and blast furnaces in various parts of the country and for special classes of work. The consumers could not deal with this material in the form in which it was recovered, and the country was fortunate in having available such an efficient, well-organised industry to provide raw material at pre-war prices in the present abnormal times.

Mr. A. T. Smyth-Tyrrell, of the London Association, was elected Deputy-President of the National Federation. Major H. E. Crawfurd was re-elected independent chairman, and Mr. G. Walter Lloyd, of Cardiff, was re-elected secretary.

ENGINEERING AFTER THE WAR

Addressing the South Midland Centre of the Institution of Electrical Engineers, Dr. A. P. M. Fleming, a Past-President of the Institution, said that some considerable time would elapse before "normal" conditions returned to the engineering industry after the war was won, and much of the burden of this period could be removed if demobilisation was gradual. Men with engineering qualifications, but no guaranteed employment, would have to be found jobs in the more active branches of engineering. Partly-trained men without industrial experience would require extra technical training. The co-operation of the larger engineering organisations must be sought and their training facilities used. The efficiency of any measures the engineering industry might take to expedite reinstalment of men must depend upon the general policy of reconstruction adopted by the Government. If this proved sufficiently bold and far-seeing, there should be no major difficulty in the way to satisfactory solution.

REGISTER OF SCIENTIFIC AND TECHNICAL WORKERS

The Ministry of Labour has now established an Appointments Department to take over the Central Register and the Supplementary Register. The Central Register contains the names of persons with high scientific and technical qualifications, including those in specified occupations who were compulsorily registered last year. The Supplementary Register contains the names of persons with administrative and managerial qualifications or with scientific and professional qualifications other than those admitting to the Central Register.

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COMPANY NEWS

(Figures for previous year in brackets.)

Robey & Company—Dividend of 5% (same).

Walter Spencer—Interim dividend of 5% (same).

Broom & Wade—Interim dividend of 7½% (same).

Coventry Machine Tool—Dividend of 8% (nil) for 1941.

Joshua Bigwood & Son—Interim dividend of 5% (same).

Ewart & Son—Net profit for 1941, £5,811 (£101); no dividends.

Brush Electrical Engineering—Dividend of 6% (nil) on the ordinary shares for 1941.

Peglers—Net profit, £105,963; dividend on the "A" and "B" ordinary shares of 23½% (same).

G. Beaton & Son—Profit for 1941, £66,337 (£55,518); dividend of 10% (same) and a bonus of 5% (same).

Pressed Steel Company—Final ordinary dividend of 17½% (same), making 27½% (same) in respect of 1941.

Allen West & Company—Net profit for the year ended January 31, £50,195 (£51,931); ordinary dividend of 7½% (same).

Laurence Scott & Electromotors—Net profit, £95,856 (£119,178); dividend of 12½% on the "A" and "B" ordinary shares (15%).

William Simons—Profit to March 31, after fees, taxation and deferred repairs, £25,862; dividend of 4% (same), leaving £17,658, which has been applied to debit balance, reducing it to £13,138.

Boulton & Paul—Net profit to September 30 last, £136,639 (£93,368); debit brought in, £22,062; taxation, £95,000; preference share dividends, £6,770; dividend of 5% on the ordinary shares (nil), £6,250; forward, £6,557.

C. & W. Walker—Profit for year to January 31, including £2,708 from subsidiary, £25,449 (£16,088); reserve for leasehold depreciation, £2,000; preference dividend of 7½%, £1,500; ordinary dividend of 10% (same), £4,765; bonus of 1s. a share (nil), £2,382; taxation, £11,647 (£7,265); forward, £14,621 (£13,267).

SURPLUS STOCKS OF METALS

The Ministry of Supply is issuing a monthly stock list containing details of surplus stocks of ferrous and non-ferrous metals in order to make known to those engaged on work of national importance what quantities of surplus processed raw materials, both ferrous and non-ferrous, are available. The items include metal in forms such as sheet, plates, strip, joists, tees, channels, bar, tube, wire, and sections. On inquiry the intending purchaser is put in touch with the holder of the surplus material. All holders of surplus stocks should send full specifications of the material available for disposal to the Directorate of Economy (Disposals), Steel House, Tothill Street, London, S.W.1, so that details can be published in the national list. Government contractors and sub-contractors should ensure that they receive a copy of the list each month. The list does not include surplus aircraft material, which will continue to be dealt with by the Ministry of Aircraft Production.

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Tamworth Foundry—£100. D. E. Kirstein, 11, Mill Ridge, Edgware, subscriber.

S. H. Muffett, 44, Newton Road, Tunbridge Wells—Engineers, etc. £3,500. S. H., R. M., and W. S. Muffett.

Ward Sheet Metal & Components, 119, Moorgate, London, E.C.2—£1,000. S. Marks, A. A. Jacobs, and W. Fox.

Wickham Precision Tool & Turning Company, Westfield Road, Winnersh, near Reading—£2,000. E. G. Wickham, E. Strudwick, L. Music, C. Saker, and S. Mogridge.

George Swift & Sons (Holdings), 177, Regent Street, London, W.1—To acquire all the issued capital of George Swift & Sons, Limited, for that purpose to enter into an agreement with the Whitehead Industrial Trust, Limited, and to carry on the business of engineers, etc. £160,000. W. P. Eastwood, S. W. Bates and J. D. Kyle.

OBITUARY

MR. JAMES FRASER, whose death at Motherwell is reported, was general secretary of the General Ironfitters' Association for 30 years.

MR. JOHN HOPE, a member of the staff of Jones & Campbell, Limited, Torwood Foundry, Larbert, Stirlingshire, for over 30 years, died suddenly on April 25.

MR. JOHN THOMAS WOOD, former chairman of John Wood & Sons (Wisewood), Limited, Wisewood Forge and Rolling Mills, Sheffield, died recently, aged 76.

MR. ARTHUR CHARLES MYERS, who died suddenly in Glasgow, was for many years associated with Shanks & Company, Limited, sanitary and general engineers, of Barrhead.

MR. G. A. ADAMS, for many years manager of A. & T. Becks & Company, Limited, solder manufacturers, Birmingham, and late agent of the Tyne Solder Company, Gateshead, died recently.

LT.-COL. J. WHITMORE GARRATT died at his home at Dudley recently at the age of 74. He was a member of the firm of Garratt & Company, Limited, firebrick manufacturers, of Cradley Heath.

AT A CONFERENCE organised by the British Standards Institution with the approval of the Minister of Production it was decided to set up immediately a small committee to prepare recommendations on factory office systems.

AT A GENERAL MEETING of the Institute of Metals to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on Wednesday, May 13, at 6 p.m., Mr. W. T. Halcrow will lecture on "Water Power and Its Application to the Production of Metals."

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Raw Material Markets

IRON AND STEEL

With the exception of the majority of the makers of light castings and a number of jobbing foundrymen, activity in the ironfoundry trade generally is maintained. The volume of orders placed among light-castings manufacturers remains comparatively meagre, due to the closing of most of the peacetime outlets and to the inability of more than a small proportion of the makers to cope with Government war contracts. The various Government departments, however, are keeping the heavy engineering works fully employed, and there is little scope for the acceptance of outside business.

Available supplies of low- and medium-phosphorus irons and hematite are still insufficient to satisfy all requirements, despite the fact that output has been stepped up to the highest possible levels. The manufacture of these grades depends on imports of foreign ores, which are coming through much less regularly than in normal times, as the conservation of shipping tonnage is an important part of the Government policy. Consequently, speciality engineers and other users of these grades of iron are having to seek elsewhere for their raw materials. In this direction they have achieved striking success; the results obtained by the incorporation of high-phosphorus and refined irons and steel scrap in their mixtures have been most gratifying, on the whole. Ample tonnages of high-phosphorus iron are available for the heavy engineers, and consumption in this section has expanded materially; on the other hand, usage in the light-castings trade, the main source of consumption in normal times, has fallen away considerably.

Consumers' stocks of foundry coke are gradually assuming extensive proportions, and stocking will be continued throughout the summer months, so that the position before the winter should be favourable. For delivery to Birmingham and Black Country stations, Durham best foundry fuel is quoted at 62s. 9d. per ton.

The accent of steel demand continues to be on the special descriptions required for the munition works and other essential consumers. Output of these grades is not yet as substantial as would be desired, but it has been improved a lot in recent months, and additional units of production are regularly coming into operation. Ordinary qualities of steel for structural engineers are in steady demand, but there is no undue pressure. Shipbuilders, wagon and tank makers, etc., are taking up large quantities of plates, but activity in the sheet mills is reduced.

DECLARING that industrial peace can be achieved only by goodwill, trust and confidence between management and labour, the executive of the Ironfounding Workers' Association of Scotland appeals to workers to give complete co-operation in all efforts towards the country's needs. There must be a policy of give and take.

NON-FERROUS METALS

While the avenues of copper supply to Britain and the United States have actually been increased since the war started, there is very little of the metal available for other than war contracts. Consumption is now much above peacetime levels, as copper is used very extensively in the manufacture of munitions and other war materials. Pre-war consumption in the United Kingdom was about 350,000 tons per annum, but it is certain that supplies now arriving here are considerably in excess of this figure. According to the War Production Board, the United States will require this year more than 2,000,000 tons of copper, despite the severe rationing of civilian allocations. Production in that country is expected to be around 100,000 tons, and the remainder will be secured from Chile and other Latin-American States, Canada, Rhodesia and the Belgian Congo.

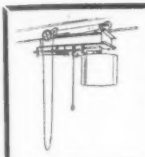
Prof. Copland, economic adviser to the Australian Government, last Thursday announced a rise in the price of tin to £A371 per ton. This increase, it is stated, is to encourage tin production from low-grade deposits in the Commonwealth. It is proposed to establish a pool by allocating £A10 per ton for the purpose of developing low-grade mines.

Spelter is being used in a variety of ways for the production of war materials. The production of shells, for example, entails the consumption of very large tonnages of brass, while high-grade zinc is needed for the manufacture of cartridge metal. Ample supplies continue to be forthcoming for these vital purposes, but civilian consumption has been cut to the bone. Lead is also in strong demand by Government departments, but the supply position is perhaps a little easier than in other non-ferrous metals, although there is none to spare for ordinary domestic use and distribution is very carefully controlled. Battery and cable makers are particularly heavy users of lead.

PROTECTIVE CLOTHING FOR SPECIAL WORK

The Board of Trade have agreed to issue coupon funds to employers enabling them to purchase protective clothing for loan to certain workpeople (male or female) who are engaged intermittently on dirty jobs which require such clothing. These coupon funds will be given only to cover the needs of workers who have from time to time to do specially dirty jobs outside their normal duties. Employers supplying clothing in these circumstances should write to the Board of Trade, Granville Court, Bournemouth, for application form WASC/DJ.1. This form must be countersigned by a Factory Inspector.

SPEAKING on his election as president of the Tees-side Chamber of Commerce on Monday, Mr. W. H. McCormack said that, after the war, control of trade would be necessary for a time, but it should be a control whose main concern was to wind up control so that business freedom could come into its own again.



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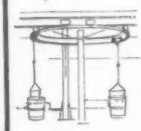

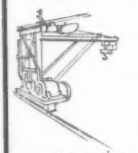

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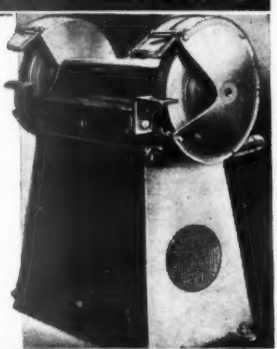

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Participating Associations : National Ironfounding Employers' Federation ; British Ironfounders' Association ; National Association of Malleable Ironfounders ; Ironfounders' National Confederation ; British Bath Manufacturers' Association ; British Malleable Tube Fittings Association ; Cast Iron Chair Association ; Greensand Pipe Founders Association of Scotland ; Cast Iron Heating, Boiler, and Radiator Manufacturers' Association ; Cast Iron Segment Association ; National Ingot Mould Association ; Cast Iron Axlebox Association ; Institute of British Foundrymen (affiliated) ; British Cast Iron Research Association (affiliated) ; British Grit Association (affiliated) ; Agricultural Engineers' Association (affiliated).

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BRITISH CAST IRON RESEARCH ASSOCIATION

21-23, St. Paul's Square, Birmingham. 'Phone : Colmore 4274-4275 ; 'Grams : *CIRA*.

Scottish Laboratories :—Foundry Technical Institute, Meek's Road, Falkirk. (Phone : 332.)

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The need for all possible conservation of man power; the demand for the maximum output of vital cast metallic products; the insistence upon the lowest cost of production; and the necessity of maintaining, and even improving, the quality of those products.

All these conditions combine to point to the only satisfactory solution to all these problems—

MECHANISATION

but it must be mechanisation particularly considered, designed and adapted to the individual site conditions; to the particular product; and with full regard to *all* the factors, economic, geographical and human, which may have any bearing on the problem.

In other words consult:—

"The Specialists in Foundry Mechanisation"

whose products

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